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CRI TECHNOLOGY DIGEST

CEMENT RESEARCH INSTITUTE OF INDIA

MINE PLANNING FOR LARGE CEMENT PLANTS

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INTRODUCTION

Among many factors imparting a new outlook to raw material winning for modern cement plants, the two most important are the larger capacity kilns and gradual introduction of and switch over to dry process of cement manufacture with suspension preheater systems. The quarries, therefore, are enjoined to produce more at a faster rate with much lower permissible tolerances in the quality of the mine output. Two other developments which have further added to the responsibilities in quarrying are the gradual depletion of large good quality and homogeneous limestone deposits, and the perceptible deterioration in the quality of supplied coal. Further, the energy economy, the crying need of the day, also deserves significant implementation through optimization of various operations in mining, ranging from blasthole drilling to transport of quarried material. The last three among the mentioned factors have also created problems for operating quarries of the old plants and have thus added further constraints in quarrying practices.

This Technology Digest views the problem in this context and suggests ways of mine planning and means of reducing quarrying costs without sacrificing the quality of the feed to cement plants.

The task is undoubtedly more complex than conceived, as each quarry is an entity by itself, wherein the mine layout, choice of machinery and their deployment, choice of haulage and transportation system, etc, are guided by a large number of factors both local as well as regional. Notwithstanding the complex effect of various factors in mining, the cost has to be kept within a specific limit, as escalations are bound to have significant impact on the economy of production and in extreme cases may even impinge upon the viability of the plant. In fact, the high landed costs of limestone for some quarries are known to be impeding the plant economy and call for indepth analysis of trouble areas in mining.

MINE PLANNING

Preliminary survey of a good number of quarries for medium to large

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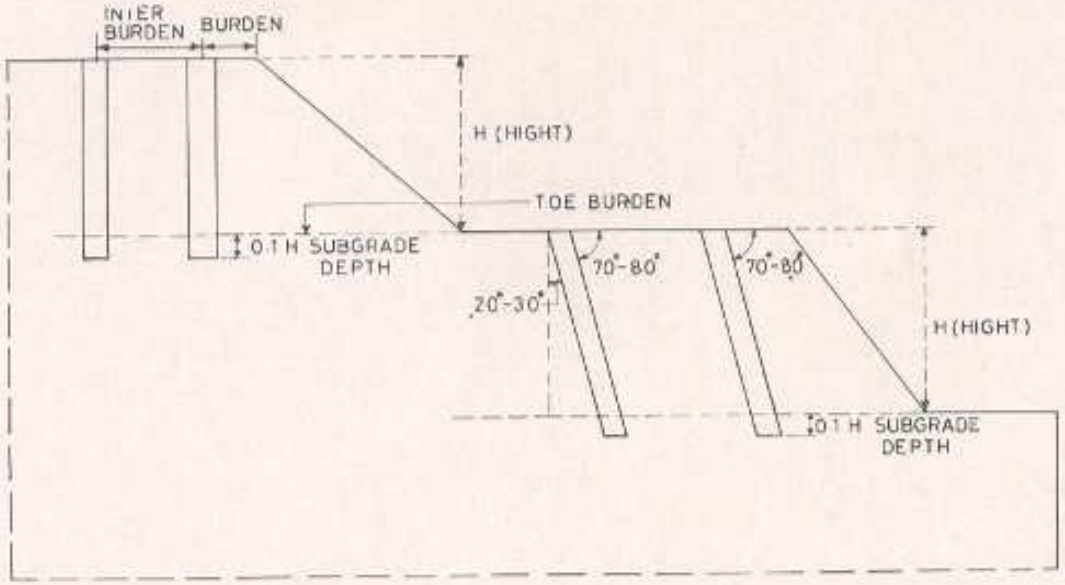
plants indicates that manual mining for large quarries is too cost-intensive. The degree of mechanization in quarrying is direct function of geographical and geological factors, which should be carefully considered during mine planning stage. Adequacy and thoroughness of input data for mine planning is a basic prerequisite for optimized quarrying. For example, the mode of occurrence of the limestone body controls the mine configuration, whereas the quality characteristics with respect to topography and depth decides the mine layout. Incompatibility between mode of occurrence and quality characteristics are known to have contributed to difficult minability, e.g, large quarries with high overburden stripping ratio as well as varying quality of marginal grade limestone have no option left but for semi-mechanized mining with consequent cost escalations. Elongated bands of limestone with pinches and swells in metamorphic rock complex could be effectively won only in adjacent isolated quarries, involving considerable in-quarry material handling efforts. The above two examples highlight the need for careful mine planning with due consideration to selective quarrying and blending of marginal quality stone.

MINING TECHNIQUES

In individual items of mining operations, the need for suitability and efficiency analysis of various techniques, rather than following traditional, weather-beaten methods, are becoming apparent and essential. Although notable changes are taking place in large scale limestone quarrying practices, these changes are somewhat more significant in choice of higher capacity machinery than in introduction of newer techniques. Crawler-mounted larger dia (150 mm) drills and down-the-hole drills are more productive with lesser operational costs and manpower requirement. Inclined drilling and sub-grade drilling which have proven to have given better fragmentation, lesser explosive consumption, minimized 'toe' problem and safe profile of blasted rocks, offer enough scope of implementation with favourable rock properties (Fig 1). Conventional explosives (OCG, special gelatine) are being gradually replaced by ANFO in many quarries. Slurry explosives of various types have been found to give better performance at lower cost. Improved blasting techniques with use of delay detonators and simplified relay systems for staggered blasting can provide any desired sequence of firing with a predetermined interval. With preliminary analysis and evaluation, this can provide better fragmentation and larger control over ground vibrations. Various methods of mechanical fragmentation of over-sized boulders (hydraulic hammers,



Vertical and inclined holes with sub grade depth on a limestone quarry

rippers, etc) can provide dual advantage of time-saving and lesser operational cost in comparison to secondary blasting.

Excavation and Loading

In excavation and loading operations the trend towards larger capacity shovels for larger mechanized quarries is quite significant. For large quarries needing selective quarrying for quality control of marginal grade or inhomogeneous stone, front-end loaders or wheel loaders can provide higher flexibility and mobility of operations, being low in capital costs. They may provide the answer where quality control is of prime importance, although the operating costs are higher. Hydraulic shovels have definite advantages over conventional cable operated shovels in their higher penetration power, precise excavation, faster loading cycle and greater mobility. Depending upon the situations and careful analysis, they may provide the best alternative for in-quarry material handling.

Haulage System

Mechanism of limestone transport from quarry to plant is bound to witness significant changes in the context of relative cost and availability of the three forms of energy used at present, namely, liquid fuel (dumpers), solid fuel (steam locomotives) and power (ropeways). The conventional dumper transport for short distances are gradually becoming uneconomic, even with gradual increase in individual dumper capacity to upto 50 tonnes. Many new large quarries in the developed countries are adopting bulk transportation techniques in place of dumpers. Under Indian conditions, with higher cost of diesel and lesser availability of coal, power based transport systems offer much larger scope. Where power is available, ropeways, so far considered suitable only for difficult, hilly or non-negotiable terrains, may provide economy and greater handling capacity in spite of high installation costs. Belt conveyors, still many times costly in installation, are also getting introduced for large plants for similar reasons. The relative merits and demerits of each system need careful cost-benefit analysis under each specific situation. Uninterrupted bulk supply of material involves high technical efficiency of the adopted system, wherein properties of the material under transport may play a key role. Degree of fragmentation, moisture content, stickiness, etc, are some properties which call for careful investigation. Material transport overlong distances or even bulk transport over short distances need installation of crusher at the quarry for optimization and economy. The type, design and capacities of such crushers should take into consideration various mining

Performance of Hydraulic Excavator, Cable Shovel and Front-End Loader in Limestone Mine

	Front-End Loader	Cable Shovel	Hydraulic Excavator
Digging	Practically no digging force	Ground preparation is necessary	Free digging without ground preparation
Penetration	Much less penetration force	Less penetration force	Higher penetration power which provides ability to work effectively
Mobility	Suitable for frequent movement when required from face to face	Lacks mobility	More mobile compared to shovels
Flexibility	Much more flexible than hydraulic shovel	Due to heavy weight less flexibility even in the same face	More flexible than shovels
Loading cycle	Slow	Moderate to slow	Fast
Precision excavation	No precise operation	Excavation is not precise as operator cannot exclude impurities in excavation and loading	Precise and selective loading from face, thereby exercising quality control
Output	Output is as low as 60% compared to a shovel with equivalent bucket capacity	Comparatively less output than hydraulic shovel	Higher output per shift
Capital cost	Low	High but lesser than hydraulic shovel	High
Operating cost	Higher than hydraulic shovel	It is higher and ripping is necessary	It is less as ripping is not required
Repair and maintenance	Easy	Easy but costlier	Difficult under dusty conditions
Operating condition	Cannot work independently for rock handling at mine faces, but can work for heap loading at separate places and in face cleaning	Difficult to work beyond boom height	Can work under any face height
Suitability	Suitable only for soft material and well blasted piles	For all types of materials	For all types of materials

parameters. Bulk transport of material from inhomogeneous deposits or isolated quarries are found to be more effective with mobile crushing plants, where quality control is one of the prime considerations. A further novel method which holds promise is pipe transport of raw material in slurry form (with subsequent filter pressing, if needed) or under pneumatic pressure. However, introduction of such a system for limestone will need adequate back-up study on technical feasibility and economic viability.

CRI SUPPORT

As a practical aid to this sphere of activity CRI has been keeping itself regularly posted with the advancements in limestone mining practices in India and abroad, and about large scale open-cast mining of other bedded deposits in India as well, apart from collecting and disseminating data on cement grade raw material resources of India. CRI is also maintaining a close link with the capative limestone mines of Indian cement plants and the quarrying difficulties generally confronted. The knowledge and information which is being continuously accumulated and updated can serve the industry in optimization and cost reduction in quarrying operations.

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